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### THE DEVONSHIRE CAVERNS, AND THEIR CONTENTS.<sup>1</sup>

ANTHROPOLOGY, on one of its numerous sides, marches with geology; and hence it is, no doubt, that I, for many years a laborer very near this somewhat ill-defined border, have been invited to assist my friends and neighbors in the work which lies before them during the association week. I have the more cheerfully accepted the invitation, from a vivid recollection, that, when on a few occasions I have come uninvited into this department, my reception has been so very cordial as to lead me to ask myself whether the reports which for many years (1864 to 1880) I laid annually before my geological brethren did not derive their chief interest from their anthropological bearings and teachings.

In 1858, a quarter of a century ago, I had the pleasure of reading to the geological section of the association the first public communication on the exploration, then in progress, of Brixham Cavern (more correctly, Brixham Windmill-hill Cavern); and as any interest connected with that paper lay entirely in the evidence it contained of the inoculation and contemporaneity of human industrial relics of a rude character, with remains of certain extinct mammals, I purpose on this occasion to lay before the department a few thoughts, retrospective and prospective, which may be said to radiate from that exploration, confining myself mainly to South Devon.

Probably nothing will better show the apparent apathy and scepticism with which, up to 1858, all geological evidence of the antiquity of man was received by British geologists generally, than the following statement of facts:—

About the beginning of the second quarter of the present century, the late Rev. J. MacEnery made Kent's Cavern, or Kent's Hole, near Torquay, famous by his researches and discoveries there. He not only found flint implements beneath a thick continuous sheet of stalagmite, but, after a most careful and painstaking investigation in the presence of witnesses, arrived at the conclusion that the flints "were deposited in their deep position before the creation of the stalagmite" (*Trans. Devon. assoc.*, iii. 330); and when it was suggested by the Rev. Dr. Buckland, to whom he at once and without reservation communicated all his discoveries, that "the ancient Britons had scooped out ovens in the stalagmite, and that through them the knives got admission to the 'diluviun,'" he replied, "I am bold to say that in no instance have I discovered evidence of breaches or ovens in the floor, but one continuous plate of stalagmite diffused uniformly over the loam" (*Ibid.*, p. 334). He added, "It is painful to dissent from so high an authority, and more particularly so from my concurrence generally in his views of the phenomena of these caves, which three years' personal observation has in almost every instance enabled me to verify" (*Ibid.*, p. 338).

It is perhaps not surprising that Dr. Buckland,

one of the leading geologists of his day, should be too tenacious of his opinion, and feel too secure in his position to yield to the statements and arguments of his comparatively young friend, MacEnery, then scarcely known to the scientific world.

That the position taken by Buckland retarded the progress of truth, and was calculated to check the ardor of research, is apparently certain, and much to be regretted. But it should be remembered, that, at least as early as 1819, he taught that "the two great points . . . of the low antiquity of the human race, and the universality of a recent deluge, are most satisfactorily confirmed by every thing that has yet been brought to light by geological investigations" (*Vindiciæ geologicae*, p. 24); that early in 1822 he reiterated and emphasized these opinions in his famous Kirkdale paper (*Phil. trans.* for 1822, pp. 171-236), which the Royal society 'crowned with the Copley medal' (*Quart. journ. geol. soc.*, vol. xiii. p. xxxiii.); that in 1823, having amplified and revised this paper, he published it as an independent quarto volume under the attractive title of '*Reliquiæ diluvianæ*,' of which he issued a second edition in 1824; and that though his acquaintance with Kent's Cavern was much less intimate than that of MacEnery, he nevertheless was, of the two, the earlier worker there, and, in fact, had discovered a flint implement in it before MacEnery had ever seen that or any other cavern, — the first tool of the kind found in any cavern, it is believed, and which in all probability was met with under circumstances not in conflict with his published opinion on the low antiquity of man. I confess that under such circumstances, human nature being what it is, the line followed by Dr. Buckland seems to me to have been that which most men would have pursued.

It was, at any rate, the line to which he adhered as late, at least, as 1837; for in his well-known '*Bridgewater treatise*,' published that year, after describing his visit to the caverns near Liège, famous through the discoveries of Dr. Schmerling, he said, "The human bones found in these caverns are in a state of less decay than those of the extinct species of beasts: they are accompanied by rude flint knives, and other instruments of flint and bone, and are probably derived from uncivilized tribes that inhabited the caves. Some of the human bones may also be the remains of individuals, who, in more recent times, have been buried in such convenient repositories. M. Schmerling . . . expresses his opinion that these human bones are coeval with those of the quadrupeds of extinct species, found with them, — an opinion from which the author, after a careful examination of M. Schmerling's collection, entirely dissents" (*Op. cit.*, i. 602).

It may be doubted, however, whether his faith in these his early convictions remained unshaken to the end. I have frequently been told by one of his contemporary professors at Oxford, who knew him intimately, that Buckland shrank from the task of preparing for the press new editions of his '*Reliquiæ diluvianæ*' and his '*Bridgewater treatise*.' 'The work,' he said, 'would be, not editing, but re-writing.'

<sup>1</sup> Address by WILLIAM PENGELLY, F.R.S., F.G.S., vice-president of the section of anthropology of the British association for the advancement of science. From *Nature*.

Mr. MacEnery intended to publish his 'Cavern researches' in one volume quarto, illustrated with thirty plates. In what appears to have been his second prospectus, unfortunately not dated, he said, "The limited circulation of works of this nature being by no means equal to the expenses attendant on the execution of so large a series [of plates], the author is obliged to depart from his original plan, and to solicit the support of those who may feel an interest in the result of his researches."

There is reason to believe that at least twenty-one of the plates were ready, and that the rough copy of much of his manuscript was written, but that, the support he solicited not being forthcoming, the idea of publishing had to be abandoned (see *Trans. Devon. assoc.*, iii. 198-201).

In 1840 Mr. R. A. C. Austen, F.G.S. (now Godwin-Austen), read to the Geological society of London a paper on the bone-caves of Devonshire, which, with some amplifications, was incorporated in his memoir on the geology of the south-east of Devonshire, printed in the transactions of the society in 1842 (2d ser. vi. 433-489). Speaking of his own researches in Kent's Cavern, he said, "Human remains, and works of art, such as arrow-heads and knives of flint, occur in all parts of the cave, and throughout the entire thickness of the clay; and no distinction founded on condition, distribution, or relative position, can be observed whereby the human can be separated from the other reliquiae" (*Ibid.*, p. 444).

He added, "My own researches were constantly conducted in parts of the cave which had never been disturbed, and in every instance the bones were procured from beneath a thick covering of stalagmite. So far, then, the bones and works of man must have been introduced into the cave before the flooring of stalagmite had been formed" (*Ibid.*, p. 446).

Though these important and emphatic statements were so fortunate as to be committed to the safe keeping of print with but little delay, and under the most favorable circumstances, they appear neither to have excited any interest, nor, indeed, to have received much, if any, attention.

In 1846 the Torquay natural history society appointed a committee, consisting of Dr. Battersby, Mr. Vivian, and myself, — all tolerably familiar with the statements of Mr. MacEnery and Mr. Austen, — to make a few diggings in Kent's Cavern for the purpose of obtaining specimens for their museum. The work, though more or less desultory and unsystematic, was by no means carelessly done; and the committee were unanimously and perfectly satisfied that the objects they met with had been deposited at the same time as the matrix in which they were inhumed. At the close of their investigation they drew up a report, which was printed in the Torquay directory for Nov. 6, 1846 (see *Trans. Devon. assoc.*, x. 162). Its substance, embodied in a paper by Mr. Vivian, was read to the Geological society of London on May 12, 1847, as well as to the British association in the succeeding June; and the following abstract was printed in the Report of the association for that year (p. 73): —

"The important point that we have established is, that relics of human art are found *beneath* the unbroken floor of stalagmite. After taking every precaution by sweeping the surface, and examining most minutely whether there were any traces of the floor having been previously disturbed, we broke through the solid stalagmite in three different parts of the cavern, and in each instance found flint knives. . . . In the spot where the most highly finished specimen was found, the passage was so low that it was extremely difficult, with quarrymen's tools and good workmen, to break through the crust; and the supposition that it had been previously disturbed is impossible."

It will be borne in mind that the same paper was read the month before to the Geological society. The council of that body, being apparently unprepared to print in their *Quarterly Journal* the statements it contained, contented themselves with the following notice, given here in its entirety (*Op. cit.*, iii. 353): — "On Kent's Cavern, near Torquay," by Mr. Edward Vivian. — In this paper an account was given of some recent researches in that cavern by a committee of the Torquay natural history society, during which the bones of various extinct species of animals were found in several situations."

It will be observed that the 'flint knives' were utterly ignored, — a fact rendered the more significant by the following announcement on the wrapper of the journal: "The editor of the *Quarterly journal* is directed to make it known to the public that the authors alone are responsible for the facts and opinions contained in their respective papers."

Such, briefly, were the principal researches in Kent's Cavern, at intervals from 1825 to 1847. Their reception was by no means encouraging: Mr. MacEnery, after incurring very considerable expense, was under the necessity of abandoning the intention of publishing his 'Cavern researches;' Mr. Austen's paper, though printed unabridged, was given to an apathetic, unbelieving world, and was apparently without effect; and Mr. Vivian's paper, virtually the report by a committee of which he was a member, was cut down to four lines of a harmless, unexciting character.

For some years nothing occurred to break the quietude, which, but for an unexpected discovery on the southern shore of Torbay, would probably have remained to this day.

Early in 1858 the workmen engaged in a limestone-quarry on Windmill Hill, overhanging the fishing town of Brixham in South Devon, broke unexpectedly a hole through what proved to be the roof of an unknown and unsuspected cavern. I visited it very soon after the discovery, and secured to myself the refusal of a lease, to include the right of exploration. As the story of this cavern has been told at some length elsewhere (see *Phil. trans.*, clxiii. 471-572; or *Trans. Devon. assoc.*, vi. 775-856), it will here suffice to say, that at the instance of the late Dr. H. Falconer, the eminent paleontologist, the subject was taken up very cordially by the Royal and geological societies of London, a committee was appointed by

the latter body, the exploration was placed under the superintendence of Mr. (now Professor) Prestwich and myself, and, being the only resident member of the committee, the actual superintendence fell of necessity to me.

The following facts connected with this cavern were, no doubt, influential in leading to the decision to have it explored:—

1. It was a virgin cave which had been hermetically sealed during an incalculably long period, the last previous event in its history being the introduction of a reindeer antler, found attached to the upper surface of the stalagmitic floor. It was therefore free from the objection, urged sometimes against Kent's Cavern, that having been known from time immemorial, and up to 1825 always open to all comers, it had perhaps been ransacked again and again.

2. It was believed, and it proved, to be a comparatively very small cavern; so that its complete exploration was not likely to require a large expenditure of time or of money.

It will be seen that the exploration was placed under circumstances much more likely to command attention than any of those which had preceded it. It was to be carried on under the auspices of the Royal and Geological societies by a committee consisting of Mr. S. H. Beckles, Mr. G. Busk, Rev. R. Everest, Dr. H. Falconer, Mr. Godwin-Austen, Sir C. Lyell, Professor Owen, Dr. J. Percy, Mr. J. Prestwich, Professor (now Sir A. C.) Ramsay, and myself,—all fellows of the Geological society, and almost all of them of the Royal society also.

It was impossible not to feel, however, that the mode of exploration must be such as would not merely satisfy those actually engaged in the work, but such as would command for the results which might be obtained the acceptance of the scientific world generally. Hence I resolved to have nothing whatever to do with 'trial pits' here and there, or with shafts to be sunk in selected places, but first to examine and remove the stalagmite floor, then the entire bed immediately below (if not of inconvenient depth), horizontally throughout the entire length of the cavern, or so far as practicable; this accomplished, to proceed in like manner with the next lower bed; and so on until all the deposits had been removed.

This method, uniformly followed, was preferable to any other, because it would reveal the general stratigraphical order of the deposits, with the amount and direction of such 'dip' as they might have, as well as any variations in the thickness of the beds; it would afford the only chance of securing all the fossils, and of thus ascertaining, not only the different kinds of animals represented in the cave, but also the ratios which the numbers of individuals of the various species bore to one another, as well as all peculiar or noteworthy collocations; it would disclose the extent, character, and general features of the cavern itself; it was undoubtedly the least expensive mode of exploration; and it would render it almost impossible to refer bones, or indications of human existence, to wrong beds, depths, or associations.

The work was begun in July, 1858, and closed at the end of twelve months, when the cavern had practically been completely emptied. An official report was printed in the *Philosophical transactions* for 1873, and all the specimens have been handed over to the British museum.

The paper on the subject mentioned at the beginning of this address was read in September, 1858, during the meeting of the association at Leeds, when I had the pleasure of stating that eight flint tools had already been found in various parts of the cavern, all of them inosculating with bones of mammalia, at depths varying from nine to forty-two inches in the cave-earth, on which lay a sheet of stalagmite from three to eight inches thick, and having *within* it and *on* it relics of lion, hyena, bear, mammoth, rhinoceros, and reindeer.

It soon became obvious that the geological apathy previously spoken of had been rather apparent than real. In fact, geologists were found to have been not so much disinclined to entertain the question of human antiquity as to doubt the trustworthiness of the evidence which had previously been offered to them on the subject. It was felt, moreover, that the Brixham evidence made it worth while, and indeed a duty, to re-examine that from Kent's Cavern, as well as that said to have been met with in river-deposits in the valley of the Somme and elsewhere.

The first-fruits, I believe, of this awakening, was a paper by Mr. Prestwich, read to the Royal society, May 26, 1859, on the occurrence of flint implements, associated with the remains of animals of extinct species in beds of a late geological period,—in France at Amiens and Abbeville, and in England at Hoxne (*Phil. trans.* for 1860, pp. 277–317). This paper contains explicit evidence that Brixham Cavern had had no small share in disposing its author to undertake the investigation, which added to his own great reputation, and rescued M. Boucher de Perthes from undeserved neglect. "It was not," says Mr. Prestwich, "until I had myself witnessed the conditions under which these flint implements had been found at Brixham, that I became fully impressed with the validity of the doubts thrown upon the previously prevailing opinions with respect to such remains in caves" (*Op. cit.*, 280).

Sir C. Lyell, too, in his address to the geological section of the British association, at Aberdeen, in September, 1859, said, "The facts recently brought to light during the systematic investigation, as reported on by Dr. Falconer, of the Brixham Cave, must, I think, have prepared you to admit that scepticism in regard to the cave evidence in favor of the antiquity of man had previously been pushed to an extreme" (*Report Brit. assoc.*, 1859, *trans. sects.*, p. 93).

It is probably unnecessary to quote further to show how very large a share the exploration at Brixham had in impressing the scientific world generally with the value and importance of the geological evidence of man's antiquity. That impression, begun, as we have seen, in 1858, has not only lasted to the present day, but has probably not yet culminated. It has

produced numerous volumes, crowds of papers, countless articles in reviews and magazines, in various countries; and perhaps, in order to show how very popular the subject became almost immediately, it is only necessary to state that Sir C. Lyell's great work on the 'Antiquity of man' was published in February, 1863; the second edition appeared in the following April; and the third followed in the succeeding November, — three editions of a bulky scientific work in less than ten months! A fourth edition was published in May, 1873.

Few, it may be presumed, can now doubt that those who before 1858 believed that our fathers had underestimated human antiquity, and fought for their belief, have at length obtained a victory. Nevertheless, every anthropologist has doubtless, from time to time,

"Heard the distant and random gun  
That the foe was sullenly firing."

The 'foe,' to speak metaphorically, seems to consist of very irregular forces, occasionally unfair but never dangerous, sometimes very amusing, and frequently but badly armed, or without *any* real armor. The Spartan law which fined a citizen heavily for going into battle unarmed was probably a very wise one.

For example, and dropping a metaphor, a pamphlet published in 1877 contains the following passage: "With regard to all these supposed flint implements and spear- and arrow-heads found in various places, it may be well to mention here the frank confession of Dr. Carpenter. He has told us from the presidential chair of the Royal academy that 'no logical proof can be adduced that the peculiar shapes of these flints were given them by human hands'" (see 'Is the book wrong? a question for sceptics,' by Hely H. A. Smith, p. 26). The words ascribed to Dr. Carpenter are put within inverted commas, and are the whole of the quotation from him. I was a good deal mystified on first reading them; for while it seemed likely that the president spoken of was the well-known member of this association, Dr. W. B. Carpenter, it was difficult to account for his being in the presidential chair of the Royal academy, and not easy to understand what the Royal academy had to do with flint implements. A little search, however, showed that the address which Dr. W. B. Carpenter delivered in 1872 from the presidential chair of, not the Royal academy, but the British association, contained the actual words quoted, followed immediately by others which the author of the pamphlet found it inconvenient to include in his quotation. Dr. Carpenter, speaking of 'common sense,' referred, by way of illustration, to the 'flint implements' of the Abbeville and Amiens gravel-beds, and remarked, "No logical proof can be adduced that the peculiar shapes of these flints were given to them by human hands; but does any unprejudiced person now doubt it?" (*Report Brit. assoc.*, 1872, p. lxxv.) Dr. Carpenter, after some further remarks on the 'flint implements,' concluded his paragraph respecting them with the following words: "Thus what was in the first instance a matter of discussion, has now become one of those 'self-evident' propositions which claim the unhesi-

tating assent of all whose opinion on the subject is entitled to the least weight."

It cannot be doubted, that, taken in its entirety (that is to say, taken as every lover of truth and fairness should and would take it), Dr. Carpenter's paragraph would produce on the mind of the reader a very different effect from that likely, and no doubt intended, to be produced by the mutilated version of it given in the pamphlet.

A second edition of the pamphlet has been given to the world. Dr. Carpenter is still in the presidential chair of the Royal academy, and the quotation from his address is as conveniently short as before.

It would be easy to bring together a large number of similar modes of 'defending the cause of truth,' to use the words of the pamphlet just noticed; but space and time forbid.

I cannot, however, forego the pleasure of introducing the following recent and probably novel explanation of cavern phenomena. In 1882 my attention was directed to two articles by one and the same writer, on 'Bone-cave phenomena.' The writer's theme was professedly the Victoria Cave, near Settle, Yorkshire, which he says was an old Roman lead-mine; but his remarks are intended to apply to bone-caves in general. He takes a very early opportunity, in the second article, of stating that "we shall have to take care to distinguish between what is truly indicated in the 'science' view from what are purely imaginary exaggerations of its natural and historical phenomena;" and he no doubt believes that he has taken this care.

"We have now," he says, "to present our own view of the Victoria Cave and the phenomena connected with it, premising that a great many of the old mines in Europe were opened by Phœnician colonists and metal-workers a thousand years before the Romans had set foot in Britain, which accounts for the various floors of stalagmite found in most caves, and also for the variety of groups of bones embedded in them. The animals represented by them, when living, were not running wild about the hills, devouring each other, as science men suppose, but the useful auxiliaries and trained drudges of the miners in their work. Some of them, as the bear, had simply been hunted, and used for food; and others of a fierce character, as the hyena, to frighten and keep in awe the native Britons. The larger species of mammalia, as the elephant, the rhinoceros, and hippopotamus, and beasts foreign to the country, the Romans, no less than the Phœnicians, had every facility in bringing with them in their ships of commerce from Carthage, or other of the African ports. These, with the native horse, ox, and stag, which are always found in larger numbers in the caves than the remains of foreign animals, all worked peacefully together in the various operations of the mines. . . . The hippopotamus, although amphibious, is a grand beast for heavy work, such as mining, quarrying, or road-making; and his keeper would take care that he was comfortably lodged in a tank of water during the night. . . . The phenomena of the Victoria Cave lead-mine differ in no

material respect from those of hundreds of others, whether of lead, copper, silver, or iron, worked in Roman and pre-Roman times in all parts of Europe. Its tunnels have all been regularly quarried and mined, *not by ancient seas*, but by the hands of historic man. Double openings have been made in every case for convenient ingress and egress during the process of excavation. Its roadways had been levelled, and holes made up with breccia, gravel, sand, and bones of beasts that had succumbed to toil, on which sledges, trolleys, and wagons could glide or run. . . . Near the entrance inside Victoria Cave were found the usual beds of charcoal, and the hearths for refining the metal; while close by, on the hillside, may still be seen the old kilns in which the men 'roasted' the metallic ores, and burned lime."

Should any one be disposed to ascribe these articles to some master of the art of joking, it need only be replied that they appeared in a religious journal (*The champion of the faith against current infidelity* for April 20 and May 11, 1882, vol. i. pp. 5 and 26), with the writer's name appended, and that I have reason to believe they were written seriously and in earnest.

It has been already intimated that Brixham Cavern has secured a somewhat prominent place in literature; and it can scarcely be needful to add that some of the printed statements respecting it are not quite correct. The following instances of inaccuracy may be taken as samples:—

The late Professor Ansted, describing Brixham Cavern in 1861, said, "In the middle of the cavern, under stalagmite itself, and actually entangled with an antler of a reindeer and the bones of the great cavern-bear, were found rude sculptured flints, such as are known to have been used by savages in most parts of the world" ('Geological gossip,' p. 209).

To be 'entangled' with one another, the antler, the bones of the cave-bear, and the flints, must have been all lying together. As a matter of fact, however, the antler was *on* the upper surface of the sheet of stalagmite, while all the relics of the cave-bear, and all the flints, were in detrital beds below that sheet. Again: the flints nearest the bear's bones in question were two in number: they were twelve feet south of the bones, and fifteen inches less deep in the bed. There was no approach to entanglement.

Should it be suggested that it is scarcely necessary to correct errors on scientific questions in works like 'Geological gossip,' professedly popular and intended for the million, I should venture to express the opinion that the strictest accuracy is specially required in such books, as the great majority of their readers are entirely at the mercy of the compilers. Those who read scientific books of a higher class are much more capable of taking care of themselves.

Professor Ansted's slip found its way into a scientific journal, where it was made the basis of a speculation (see *Geologist*, 1861, p. 246).

The most recent noteworthy inaccuracies connected with this famous cavern are, so far as I am aware, two in the English edition of Prof. N. Joly's 'Man before metals' (1883).

According to the first, "an entire left hind-leg of *Ursus spelaeus* was found lying above the incrustation of stalagmite which covered the bones of other extinct species and the carved flints" (p. 52).

It is only necessary, in reply to this, to repeat what has been already stated: all the bones of cave-bear found in the cavern were in beds *below* the stalagmite.

The following quotation from the same work contains the second inaccuracy, or, more correctly, group of inaccuracies, mentioned above: "We may mention, among others, the cave at Brixham, where, associated with fragments of rude pottery, and bones of extinct species, heaps of oyster-shells and other salt-water mollusks occur, as well as fish-bones of the genus *Scarus*" (p. 104).

I am afraid there is no way of dealing with this paragraph except that of meeting all its statements with unqualified denials. In short, Brixham Windmill-hill Cavern contained no pottery of any kind whatever, not a single oyster-shell, nor even a solitary bone of any species of fish. One common limpet-shell was the only relic of a marine organism met with in the cavern.

As already intimated, the result of the researches at Brixham quickened a desire to re-examine the Kent's Cavern evidence; and this received a considerable stimulus from the publication of Sir C. Lyell's 'Antiquity of man' in 1863. Having in the mean time made a careful survey of the cavern, and ascertained that there was a very large area in which the deposits were certainly intact, to say nothing of unsuspected branches which in all probability would be discovered during a thorough and systematic exploration, I had arrived at the conclusion, that, taking the cavern at its known dimensions merely, the cost of an investigation as complete as that at Brixham would not be less than £1,000.

Early in 1864 I suggested to Sir C. Lyell that an application should be made to the British association, during the meeting to be held at Bath that year, for the appointment of a committee, with a grant of money, to make an exploration of Kent's Cavern; and it was decided that I should take the necessary steps in the matter. The proposal being cordially received by the committee of the Geological section, and well supported in the committee of recommendations, a committee—consisting of Sir C. Lyell, Mr. J. Evans, Mr. (now Sir) J. Lubbock, Prof. J. Phillips, Mr. E. Vivian, and myself (honorable secretary and reporter)—was appointed, with £100 placed at its disposal. Mr. G. Busk was added to the committee in 1866, Mr. W. Boyd Dawkins in 1868, Mr. W. Ayshford Sanford in 1869, and Mr. J. E. Lee in 1873. The late Sir L. Palk (afterwards Lord Haldon), the proprietor, placed the cavern entirely under the control of the committee during the continuance of the work. The investigation was begun on March 28, 1865, and continued without intermission to June 19, 1880, the committee being annually re-appointed, with fresh grants of money, which in the aggregate amounted to £1,900, besides £63 received from various private sources.

The mode of exploration was essentially the same as that followed at Windmill Hill, Brixham; but as Kent's Cavern, instead of being a series of narrow galleries, contained a considerable number of capacious chambers, and as the aim of the explorers was to ascertain not merely what objects the deposits contained, but their exact position, their distribution, their condition, their collocation, and their relative abundance, the details had to be considerably more elaborate, while they remained so perfectly simple that the workmen had not the least difficulty in carrying them out, under my daily superintendence. The process being fully described in the First annual report by the committee (see *Report Brit. assoc.*, 1865, pp. 19, 20), it is unnecessary to repeat it here.

Mr. Godwin-Austen, while agreeing with Mr. MacEnery that flint implements occurred under the stalagmite, contended that they were found throughout the entire thickness of the cave-earth. MacEnery, on the other hand, was of opinion that in most cases their situation was intermediate between the bottom of the stalagmite and the upper surface of the cave-earth; and while admitting that occasionally, though rarely, they had been met with somewhat lower, he stated that the greatest depth to which he had been able to trace them was not more than a few inches below the surface of the cave-earth (*Trans. Devon. assoc.*, iii. 326, 327). The committee soon found themselves in a position to confirm Mr. Godwin-Austen's statement, and to say with him that "no distinction founded on condition, distribution, or relative position, can be observed whereby the human can be separated from the other reliquiae" (*Trans. geol. soc.*, 2d ser. vi. 444).

Mr. MacEnery's 'Plate F' contains seven figures of three remarkable canine teeth, and the following statement respecting them: "Teeth of *Ursus cultridens*, found in the cave of Kent's Hole, near Torquay, Devon, by Rev. Mr. MacEnery, January, 1826, in Diluvial Mud mix'd with Teeth and Gnaw'd Bones of Rhinoceros, Elephant, Horse, Ox, Elk, and Deer, with Teeth and Bones of Hyænas, Bears, Wolves, Foxes, etc."

It is worthy of note, that no other plate in the entire series names the date on which the specimens were found, or the mammals with whose remains they were commingled. This arose probably from the fact, well known to MacEnery, that no such specimens had been found elsewhere in Britain; and possibly also to emphasize the statements in his text, should any doubt be thrown on his discovery.

It is, no doubt, unnecessary to say here that the teeth belonged to a large species of carnivore, to which, in 1846, Professor Owen gave the name of *Machairodus latidens*. MacEnery states that the total number of teeth he found were five upper canines and one incisor, and the six museums in which they are now lodged are well known.

A considerable amount of scepticism existed for many years in some minds, as to whether the relics just mentioned were really found in Kent's Cavern, it being contended, that, from its zoological affinities, *Machairodus latidens* must have belonged to an earli-

er fauna than that represented by the ordinary cave-mammals; and various hypotheses were invented to explain away the difficulty, most of them, at least, being more ingenious than ingenuous. Be this as it may, it was naturally hoped that the re-exploration of the cavern would set the question at rest forever; and it was not without a feeling of disappointment that I had to write seven successive annual reports without being able to announce the discovery of a single relic of *Machairodus*. Indeed, the greater part of the eighth report was written, with no better prospect, when, while engaged in washing a 'find' met with on July 29, 1872, I found that it consisted of a well-marked incisor of *Machairodus latidens*, with a left ramus of lower jaw of a bear, in which was one molar tooth. They were lying together in the first or uppermost foot-level of cave-earth, having over it a continuous sheet of granular stalagmite 2.5 feet thick. There was no longer any doubt of MacEnery's accuracy; no doubt that *Machairodus latidens* was a member of the cave-earth fauna, whatever the zoological affinities might say to the contrary; nor was there any doubt that man and *Machairodus* were contemporaries in Devonshire.

I cannot pass from this case without directing attention to its bearing on negative evidence. Had the exploration ceased on July 28, 1872, — the day before the discovery, — those who had always declined to believe that *Machairodus* had ever been found in the cavern would have been able to urge, as an additional and apparently conclusive argument, that the consecutive, systematic, and careful daily labor of seven years and four months had failed to show that their scepticism was unwarranted. Nay, more: had the incisor been overlooked, — and, being but a small object, this might very easily have occurred, — they might finally have said '15.25 years' labor;' for, so far as is known, no other relic of the species was met with during the entire investigation. In all probability, had either of these by no means improbable hypotheses occurred, geologists and paleontologists generally would have joined the sceptics; MacEnery's reputation would have been held in very light esteem, and, to say the least, his researches regarded with suspicion.

When its exploration began, and for some time after, the committee had no reason to believe or to suspect that the cavern contained any thing older than the cave-earth: but, at the end of five months, facts pointing apparently to earlier deposits began to present themselves; and, at intervals more or less protracted, additional phenomena, requiring apparently the same interpretation, were observed and recorded. But it was not until the end of three full years that a vertical section was cut, showing in undisturbed and clear succession, not only the cave-earth with the granular stalagmite lying on it, but, under and supporting the cave-earth, another, thicker and continuous, sheet of stalagmite (appropriately termed crystalline), and below this, again, an older detrital accumulation, known as the breccia, made up of materials utterly unlike those of the cave-earth.

The breccia was just as rich as the cave-earth in osseous remains, but the lists of species represented by the two deposits were very different. It will be sufficient to state here, that while remains of the hyena prevailed numerically very far above those of any other mammal in the cave-earth, and while his presence there was also attested by his teeth-marks on a vast number of bones; by lower jaws (including those of his own kith and kin), of which he had eaten off the lower borders as well as the condyles; by long bones broken obliquely, just as hyenas of the present day break them; and by surprising quantities of his coprolites, — there was not a single indication of any kind of his presence in the breccia, where the crowd of bones and teeth belonged almost entirely to bears.

No trace of the existence of man was found in the breccia until March, 1869, — that is, about twelve months after the discovery of the deposit itself, — when a flint flake was met with in the third foot-level, and was believed not only to be a tool, but to bear evidence of having been used as such (see *Report Brit. assoc.*, 1869, pp. 201, 202). Two massive flint implements were discovered in the same deposit in May, 1872; and at various subsequent times other tools were found, until, at the close of the exploration, the breccia had yielded upwards of seventy implements of flint and chert.

While all the stone tools of both the cave-earth and the breccia were paleolithic, and were found inosculating with remains of extinct mammals, a mere inspection shows that they belong to two distinct categories. Those found in the breccia — that is, the more ancient series — were formed by chipping a flint nodule or pebble into a tool; while those from the cave-earth, the less ancient series, were fashioned by first detaching a suitable flake from the nodule or pebble, and then trimming the flake, not the nodule, into a tool.

It must be unnecessary to say that the making of nodule-tools necessitated the production of flakes and chips, some of which were no doubt utilized. Such flakes, however, must be regarded as accidents, and not the final objects the workers had in view.

It is worthy of remark, that in one part of the cavern, upwards of a hundred and thirty feet in length, the excavation was carried to a depth of nine feet, instead of the usual four feet, below the bottom of the stalagmite; and that, while no bone of any kind occurred in the breccia below the seventh foot-level, three fine flint nodule-tools were found in the eighth, and several flint chips in the ninth or lowest foot-level.

It may be added that the same fact presented itself in the lowest or corresponding bed in Brixham Windmill-hill Cavern. In short, in each of the two famous Devonshire caverns the archeological zone reached a lower level than the paleontological.

That the breccia is of higher antiquity than the cave-earth, is proved by the unquestionable evidence of clear, undisturbed superposition; that they represent two distinct chapters and eras in the cavern history, is shown by the decided dissimilarity of the

materials composing them, the marked difference in the osseous remains they contained, and the strongly contrasted characters of the stone implements they yielded; and that they were separated by a wide interval of time, may be safely inferred from the thickness of the bed of stalagmite between them.

It is probable, however, that the fact most significant of time and physical change is the presence of the hyena in the cave-earth or less ancient, but not in the breccia or more ancient, of the two deposits. I called attention to this fact in a paper read to this department ten years ago (see *Report Brit. assoc.*, 1873, pp. 209–214), and at greater length elsewhere in 1875 (see *Trans. Plym. inst.*, v. 360–375). Bearing in mind the cave-haunting habits of the hyena, the great preponderance of his remains in the cave-earth, and their absence in the breccia, it seems impossible to avoid the conclusion that he was not an occupant of Britain during the earlier period.

The acceptance of this conclusion, however, necessitates the belief, 1<sup>o</sup>, that man was resident in Britain long before the hyena was; 2<sup>o</sup>, that it was possible for the hyena to reach Britain between the deposition of the breccia and the deposition of the cave-earth: in other words, that Britain was a part of the continent during this interval.

Sir C. Lyell, it will be remembered, recognized the following geographical changes within the British area between the newer pliocene and historical times (see 'Antiquity of man,' edition 1873, pp. 331, 332): —

Firstly, A pre-glacial continental period, towards the close of which the Forest of Cromer flourished, and the climate was somewhat milder than at present.

Secondly, A period of submergence, when the land north of the Thames and Bristol Channel, and that of Ireland, was reduced to an archipelago. This was a part of the glacial age, and icebergs floated in our waters.

Thirdly, A second continental period, when there were glaciers in the higher mountains of Scotland and Wales.

Fourthly, The breaking-up of the land through submergence, and a gradual change of temperature, resulting in the present geographical and climatal conditions.

It is obvious, that if, as I venture to think, the Kent's Cavern breccia was deposited during the first continental period, the list of mammalian remains found in it should not clash with the list of such remains from the Forest of Cromer, which, as we have just seen, flourished at that time. I called attention to these lists in 1874, pointing out, that, according to Professor Boyd Dawkins ('Cave-hunting,' p. 418), the forest-bed had at that time yielded twenty-six species of mammals, sixteen of them being extinct and ten recent; that both the breccia and the forest-bed had yielded remains of the cave-bear, but that in neither of them had any relic or trace of hyena been found. A monograph on the 'Vertebrata of the forest-bed series' was published in 1882 by Mr. E. T. Newton, F.G.S., who, including many additional species found somewhat recently, but eliminating all those about which there was any uncertainty, said, "We still



have forty-nine species left, of which thirty are still living and nineteen are extinct" (p. 135). Though the number of the species has thus been almost doubled, and the presence of the cave-bear remains undoubted, it continues to be the fact that no trace of the hyena has been found in the forest-bed, and no suspicion exists as to his probable presence amongst the eliminated uncertain species.

It should be added, that no relic or indication of hyena was met with in the 'fourth bed' of Brixham Windmill-hill Cavern, believed to be the equivalent of the Kent's Hole breccia.

I am not unmindful of the fact that my evidence is negative only, and that raising a structure on it may be building on a sandy foundation. Nevertheless, it appears to me, as it did ten years ago, strong enough to bear the following inferences:—

1. That the hyena did not reach Britain until its last continental period.

2. That the men who made the paleolithic nodule-tools found in the oldest known deposit in Kent's Cavern arrived during the previous great submergence, or, what is more probable, — indeed, what alone seems possible, unless they were navigators, — during the first continental period. In short, I have little or no doubt that the earliest Devonians we have sighted were either of glacial, or, more probably, of pre-glacial age.

It cannot be necessary to add, that while the discovery of remains of hyena in the forest-bed of Cromer, or any other contemporary deposit, would be utterly fatal to my argument, it would leave intact all other evidence in support of the doctrine of British glacial or pre-glacial man.

Some of my friends accepted the foregoing inferences in 1873; while others, whose judgment I value, declined them. Since that date no adverse fact or thought has presented itself to me; but through the researches and discoveries of others in comparatively distant parts of our island, and especially in East Anglia, the belief in British pre-glacial man appears to have risen above the stage of ridicule, and to have a decided prospect of general scientific acceptance at no distant time.

I must, before closing, devote a few words to a class of workers who are 'more plague than profit.'

The exuberant enthusiasm of some would-be pioneers in the question of human antiquity results occasionally in supposed 'discoveries,' having an amusing side; and not unfrequently some of the pioneers, though utter strangers, are so good as to send me descriptions of their 'finds,' and of their views respecting them. The following case may be taken as a sample: in 1881 a gentleman of whom I had never heard wrote, stating that he was one of those who felt deeply interested in the antiquity of man, and that he had read all the books he could command on the subject. He was aware that it had been said by one paleontologist to be "unreasonable to suppose that man had lived during the eocene and miocene periods," but he had an indistinct recollection that another eminent man had somewhere said that "man had probably existed in England during a tropical

carboniferous flora and fauna." He then went on to say, "I have got that which I cannot but look upon as a fossil human skull. I have endeavored to examine it from every conceivable stand-point, and it seems to stand the test. The angles seem perfect; the contour, the same, but smaller in size than the average human head: but that, in my opinion, is only what should be expected, if we assume that man lived during the carboniferous period, in spite of what Herodotus says about the body of Orestes." Finally he requested to be allowed to send me the specimen. On its arrival, it proved, of course, to be merely a stone; and nothing but a strong 'unscientific use of the imagination' could lead any one to believe that it had ever been a skull, human or infrahuman.

It may be added, that a few years ago a gentleman brought me what he called, and believed to be, 'three human skulls, and as many elephants' teeth,' found from time to time during his researches in a limestone-quarry. They proved to be nothing more than six oddly-shaped lumps of Devonian limestone.

So far as Britain is concerned, cave-hunting is a science of Devonshire birth. The limestone-caverns of Oreston, near Plymouth, were examined with some care, in the interests of paleontology, as early as 1816, and subsequently as they were successively discovered. The two most famous caverns of the same county — one on the northern, the other on the southern, shore of Torbay — have been anthropological as well as paleontological studies, and, as we have seen, have had the lion's share in enlarging our estimate of human antiquity. The researches have, no doubt, absorbed a great amount of time and labor, and demanded the exercise of much care and patience; but they have been replete with interest of a high order, which would be greatly enhanced if I could feel sure that your time has not been wasted, nor your patience exhausted, in listening to this address respecting them.

## LETTERS TO THE EDITOR.

### Tree-growth.

THE 'influence of winds upon tree-growth,' causing the asymmetry to which Mr. Kennedy calls attention in *SCIENCE* for Oct. 5, is noticeable to a remarkable degree among conifers in the mountains of the western half of the United States. The stunted, ground-hugging evergreens, which advance a little way above the limit of ordinary timber-growth on lofty mountains, are pressed to the earth by the steady gales as much as by overbearing snows, if not more. Evidence of this is found in the fact, that, where a cleft or little hollow occurs at or in advance of timber-line, the trees will stand straight and shapely within it as high as its rim (although in such nooks the snows lie longest and most deeply), above which they will be deformed, or unable to grow at all. This bending of the trees, the whole skirt of a forest, away from the edge of a precipice, or on a hilltop over which the wind sucks through the funnel of a cañon, is so common as to be seen every day by one travelling through the Rockies or the Sierra Nevada. It is particularly true in the Sierra San Joan, where the radiation of the vast adjacent sage-plains produces an